ROBERT A. DANE, ET. AL.

UNMANNED OCEAN VEHICLE

Retro: Yes

Expedited: No Docket Number SOLAR 1

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TO: **Licensing and Review**

FAX #: 571-273-0185

FROM: Brian J. Teague

DATE: May 7, 2010

PAGES 36, including this cover sheet

SUBJECT: U.S. Patent Application
Serial No. 10/565,449
UNMANNED OCEAN VEHICLE

OUR REF: Our Docket No. SOLAR 1

COMMENTS: **PLEASE PROCEED IN AN EXPEDITED FASHION**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Robert A. Dane et al.	
Application No.: 10/565,449	Confirmation No. 9828
Filed: August 1, 2006	Group Art Unit: 3617
Title: UNMANNED OCEAN VEHICLE	Examiner: Vasudeva, Ajay
Attorney Docket No.: SOLAR 1	

Mail Stop Petitions
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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LICENSING & REVIEW

PETITION FOR RETROACTIVE FOREIGN FILING LICENSE UNDER 37 CFR §5.25

Dear Sir:

In accordance with 37 CFR 5.25, the undersigned respectfully petitions for a retroactive foreign filing license. The present Petition is being submitted before payment of the issue fee. Petitioner submits herewith the fee set forth in § 1.17(g). In addition, petitioner submits herewith the Declaration of Mark A. Smith as required by 37 CFR § 5.25(a)(3).

The Declaration of Mark A. Smith addresses the absence of a secrecy order, Applicants' diligence in obtaining a license, and an explanation of why the material was filed abroad without the required license.

Unlicensed patent application material was filed in Australia, in Australian provisional patent application number 2004902116, which was filed on April 21, 2004. Unlicensed patent application material was also filed in International Application No. PCT/AU2004/001014 on July 30, 2004.

The patent application material was filed in the United States, in US provisional patent application serial number 60/599,784, which was filed on July 22, 2004. The content of US provisional patent application serial number 60/599,784 is attached as Petition Exhibit A. As can be readily seen in the attached Petition Exhibit A, the content of US provisional patent

application serial number 60/599,784 largely coincides with the content of Australian provisional patent application number 2004902116. A foreign filing license was granted on September 13, 2004 for US provisional patent application serial number 60/599,784 (see filing receipt attached as Petition Exhibit B).

Even though the above-captioned patent application does not claim priority to US provisional patent application serial number 60/599,784, the content of the above-captioned patent application largely coincides with the content of US provisional patent application serial number 60/599,784. As a foreign filing license was granted for US provisional patent application serial number 60/599,784 on September 13, 2004, a period of less than five months passed between filing the proscribed patent applications (the Australian provisional patent application and the PCT application) and obtaining a foreign filing license for the material in question. As such, all other patent applications (including several non-US national phase applications) that were filed prior to the grant of a foreign filing license on November 25, 2006 for the above-captioned patent application were nonetheless covered by the foreign filing license granted for US provisional patent application serial number 60/599,784.

The Commissioner is hereby authorized to charge any deficiencies in payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 50-2127.

Respectfully submitted,

Date: **May 7, 2010**

Brian J. Teague
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EXHIBIT A to PETITION FOR RETROACTIVE FOREIGN FILING LICENSE

US Provisional Patent Application Serial No. 60/599,784

PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(c).

Address to: Commissioner for Patents P.O. Box 1450 Alexandria, VA. 22313-1450	Docket Number 597000.01111 (SS)

INVENTOR(s)/APPLICANT(s)

LAST NAME	FIRST NAME	MIDDLE INITIAL	RESIDENCE (CITY AND EITHER STATE OR FOREIGN COUNTRY)
DANE	Robert	A	Sydney, AU

☐ Additional inventors are named on separately numbered sheets attached hereto.

TITLE OF THE INVENTION (280 CHARACTERS MAX)

UNMANNED DRONE VESSEL

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27557
PATENT TRADEMARK OFFICE

ENCLOSED APPLICATION PARTS

☒ Specification including Claims and Abstract — *Number of Pages:* 16
☒ Drawing(s) — *Number of Sheets:* 6
☐ Application Data Sheet
☐ CD(s), Number
☐ Other (specify):

METHOD OF PAYMENT

☒ Applicant claims small entity status. See 37 C.F.R. 1.27

PROVISIONAL FILING FEE AMOUNT $80.00

☐ A check or money order is enclosed to cover the Provisional Filing Fees

☒ The Commissioner is hereby authorized to charge filing fees and credit any overpayment to Deposit Account Number 23-2185

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are:

Respectfully Submitted,

July 22, 2004
DATE

Michael C. Greenbaum
Registration Number 28,419

APPLICATION FOR UNITED STATES LETTERS PATENT

TITLE: UNMANNED DRONE VESSEL

INVENTOR: Robert A. DANE

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Docket No. 597000.0111

UNMANNED DRONE VESSEL

This application claims priority of Australian Application No. 2003-903968 filed July 28, 2003 entitled Aquatic Animal Shaped Unmanned Drone Vessel, the disclosure of which is incorporated herein in its entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to drone vessels for marine use. In particular, although not exclusively, the invention relates to unmanned marine drones utilising renewable energy sources which enable extended periods of operation, such as in remote ocean surface surveillance.

Discussion of the Background Art

The military, governmental and commercial uses for unmanned drones in warfare, exploration, research and monitoring applications at sea are numerous. The ability of conventional platforms, such as ships and buoys, to gather data and information in these applications is limited, particularly when compared to the vastness of the world's oceans. Ships are expensive to build, man, and operate. Buoys, either fixed or floating, generally provide only pinpoint coverage. Whilst some additional data may now be gathered remotely by satellites, they are more expensive and their sensors can provide very limited ocean data.

The sensors and instruments available to gather oceanographic data and information directly are well developed. It is clear that modern communications and information technology may be used to fully exploit extended networks of instruments and sensors, such as described in US Pat. No. 5,894,450 to Schmidt *et al.* However, a desirable element is an inexpensive, mobile, and self-sustaining platform that could provide power and connectivity for ocean surveillance, research and other applications requiring endurance.

Conventional drone vessels, such as described in US Pat. No. 5,713,293 to Shiffler *et al.* or the Spartan "scout" vessel proposed by the US Naval Undersea Warfare Centre of Newport, Rhode Island, USA, typically employ conventional fossil fuelled power units that provide a limited range. Conventional drones, at

least when operating in a semi-autonomous mode, are also subject to the threat posed by collision or close encounters with larger vessels.

SUMMARY OF THE INVENTION

Object of the Invention

It is an object of the invention to provide a drone vessel for marine use which addresses the drawbacks of prior art drone vessels proposed for warfare, exploration research and monitoring applications at sea, desirably for extended periods and/or over longer operating ranges.

Disclosure of the Invention

The use of solar energy to supplement conventional energy sources, such as fossil fuels or wind energy, for marine vessels has been demonstrated by the present applicant in International Patent Publication No. WO 98/21089, which describes wing sails which include solar collectors. It has now been realised that hybrid propulsion systems, such as wing sails with solar collectors, can provide a source of energy for unmanned drone vessels, thereby providing enhanced operating range. A wing sail of this type may be pivotally mounted to a hull or body of the drone whereby when erected can sail under wind power and, if angled optimally to sun, also collect solar energy. Alternatively the wing sail may be declined along length of the drone hull to reduce the drone's drag in undesirable wind conditions and its silhouette whilst continuing to collect solar energy.

In one broad aspect, the invention resides in an unmanned submersible drone vessel for operating either at or below the surface of a body of water, said vessel including:

- an enclosed hull having a payload bay;
- a hybrid propulsion system having energy collection means and energy storage means adapted for utilising at least solar energy and wind energy;
- a plurality of sensors for detecting predetermined environmental parameters; and
- a communications system for transmitting data from said sensors about selected environmental parameters to, and for receiving command signals from, one or more remote stations and/or cooperating drone vessels.

The outer configuration of the hull or body of the drone suitably has the general appearance of an aquatic animal, such as a fish, dolphin, whale, tortoise, squid, octopus or other suitable aquatic animal.

Preferably, the enclosed hull is adapted to facilitate selective operation at or below the water surface. Suitably the hull may include ballast tanks for selective submerging and surfacing of the drone vessel.

Most preferably the hybrid propulsion system includes a wing sail having an aerofoil configuration for propelling the vessel using wind energy and having solar energy collectors, such as photovoltaic cells, disposed on the surface of the wing sail. Preferably the wing sail may be lowered to a declined position along the body of drone to reduce drag whilst continuing to collect solar energy.

The energy storage means of the hybrid propulsion system suitably includes electrical storage cells, such as batteries or capacitors, coupled to the solar energy collectors. The hybrid propulsion system may further include an electrical machine mechanically coupled to a fluid drive element such as a propeller, jet, or oscillating tail member. The electrical machine may be supplied from the storage cells to drive the element in a motor mode or, in the alternative, the electrical machine may be driven by the drive element through wave action, water currents or during regenerative sailing to charge the storage cells in a generator mode. The capacitors or other rapid energy discharge devices, such as fluid accumulators, may provide the drone vessel with a short sprint capability.

The payload bay is preferably internally powered in order to carry devices including sensors for oceanographic or military use, live-saving or fire-fighting equipment for search and rescue, and weapons relating to desired drone vessel operations. The environmental sensors may include an anemometer, a wind vane, radar, an optical band sensor, an infrared band sensor, a chemical and/or biological sensor, an acoustic sensor, and a bathymetric sensor 218.

The communications system may include a GPS receiver, a LFB/SWB/marine band receiver, and a satellite receiver, together with suitable antenna arrays for each.

Most suitably the drone is able to dive under the surface for prolonged periods using stored energy to avoid ship, storms or for stealth operations. If required, the hybrid propulsion system may further include a fuel cell for

emergency use, such as emptying ballast tanks to surface after a prolonged period of submerged operation.

In other modes of operation, the drones will deployed and utilize command and control relay centres, commanding individual drones or operating in groups of, for example up to 1,000 or more, unmanned drone vessels. The drones may operate via remote control systems, for example space-borne systems (eg. satellites) or airborne intelligence systems (e.g. planes or balloons). If required, the drones may utilise a relay type communication system using communications channels provided between individual drones in the group, thereby relaying messages via a chain of command back to a command centre on a ship or at a land base.

BRIEF DETAILS OF THE DRAWINGS

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings illustrate preferred embodiments of the invention, and wherein:

FIG. 1 is an overview diagram of a hybrid propulsion system suitable for first embodiment and second embodiments of the invention;

FIG. 2 is a side elevational view representing a drone vessel of a first embodiment suited to low cost construction;

FIG. 3 is a top plan view representing a drone vessel of the first embodiment;

FIG. 4 is a side elevational view representing a drone vessel of a second embodiment of the invention suited to stealth operations;

FIG. 5 is a front elevational view representing the drone vessel of the second embodiment;

FIG. 6 is a top plan view representing a drone vessel of the second embodiment;

FIG. 7 is a top plan view representing a drone vessel of a third embodiment of the invention, suited to high load capacity operations;

FIG. 8 is a side elevational view of the drone vessel of the third embodiment;

FIG. 9 is a side elevational view of a drone vessel of a fourth embodiment of the invention suited to search and rescue operations;

FIG. 10 is an end elevational view of the drone vessel of the fourth embodiment;

FIG. 11 is a top plan view of the drone vessel of the fourth embodiment; and

FIG. 12 is a schematic block diagram of a command and control module for drone vessels of the embodiments.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

A hybrid propulsion system 100 for embodiments of drone vessels of the invention is depicted in FIG. 1. The propulsion system includes arrays of photovoltaic cells 101, which may be mounted on or integral with surfaces of the vessel that are able to collect solar energy 102. These collection surfaces include surfaces 103 of wing sails (not shown) which can be selectively positioned for collecting solar energy, as will be described below. The photovoltaic cells 101 supply electrical energy to storage cells, such as batteries 104. The batteries in turn supply DC power for hotel loads 105 of the vessel and also to an electric motor/generator 106 which drives a propeller 107 in the "motor" mode.

When the wing sails which are fixed to the vessel are erected and "under sail", they can also propel the vessel using the available wind energy 108. The propeller 106 may also be configured to collect energy from the flow of water relative to the vessel, i.e. passing current or regenerative sailing, and thereby assist re-charging in the batteries by driving the electric motor/generator in the "generator" mode. A further option for re-charging the batteries or providing emergency stand-by power when environmental conditions are unsatisfactory is through use of an auxiliary fuel cell 109.

Turning to FIGs 2 and 3 there is represented a drone vessel 200 of a first embodiment of the invention which is able to be constructed at relatively low cost. The vessel includes an enclosed hull 201 constructed of fiberglass material, having a length of # to # meters (16-30 feet), a beam of about # to # meters (7-15 feet) and weighing in the region of 400 to 2000 kg (# to # pounds). The hull encloses a payload compartment 202 for a payload weighing in the region of 100 to 500kg (# to # pounds).

The drone vessel includes a hybrid propulsion system have two retracting wing sails 203 are fixed to the hull 201 for collecting wind energy to propel the

vessel. Both the surface of the sails 204 and the upper surface of the hull or deck 205 include sections covered with photovoltaic cells. The photovoltaic cells convert ambient solar energy into electrical energy for supply to a battery bank 206. The battery bank is in turn electrically coupled to an electrical machine 207 which is mechanically coupled to a propeller 208. A control module 209 is coupled to each of these components of the hybrid propulsion system and also to a rudder 210, to guide the vessel and optimize the use of available solar energy and wind energy, in order to propel the vessel along a desired course. The control module 209 includes a guidance system having a global positioning system receiver with automatic sequencing, tracking and storage capabilities.

The payload compartment accommodates electronic systems 211 supporting environmental monitoring and data logging equipment, including an anemometer/wind vane 212, radar 213, and optical and infrared band sensors 214, hull-mounted chemical/biological sensors 215, acoustic sensors, both fixed 216 and optionally deployable 217, and a bathymetric sensor 218. Suitable antenna arrays 219 are also provided for the GPS receiver and communications purposes.

Utilising a wind and solar electric propulsion system 100 of the type described in relation to FIG 1, it is anticipated that the vessel could reach a hull speed of about 4 to 6 knots when sailing in around 15 knot winds. In the solar powered operating mode, the vessel could maintain about 2 to 3 knots for a 24 hour period. Thus the typical average operating speed of the vessel is around 1.5 to 3 knots, depending on its size and weight. It is estimated that the power required for the payload will be in the order of 0.5 to 1.2 kW (# - #hp), and that standby power of # to # kW (20 - 40hp) could be provided by an optional fuel cell 220.

In FIGs 4 to 6 there is depicted a drone vessel 300 of a second embodiment of the invention suited to stealth or surveillance roles. The enclosed hull 301 is constructed of a carbon fibre composite material and has the general appearance of an aquatic animal, here a dolphin or porpoise. Accordingly the hull has a length of about (8 - 12 feet), a width of about 32 - 40 inches and a weight of 320 to 480 kg (# - # pounds). The enclosed hull 301 includes in internal payload bay 302 of 1.75m x 0.35m (5ft x 1ft) +/-20% for accommodating a payload weight of 100 kg (# pounds) +/- 20%.

The drone includes a hybrid propulsion system including an electric motor 303, a fuel cell 304, electrical storage cells such as a battery bank 305 and a photovoltaic array 306 for collecting solar energy. The PV array 306 is provided on the surface of a wing sail 308 which is attached to the hull 301. It is anticipated that a 1 m^2 wing sail operating in a 26 knot trade wind for example would provide about 1.7 kW, and thus drive the vessel at 3 knots +/-20%.

Utilising solar energy, it is anticipated that the photovoltaic array 306 could generate 1.2 kW which would supply the electric motor 303 to drive a propeller 307, delivering a vessel average speed of 3 knots +/-20%. The electric motor 303 is overrated by about 300% at 30 kW, to give 20 knot+ sprint speed in short bursts. The battery bank 305, a fuel cell (not shown) which is rated at 10 hp +/-20%, and a capacitor bank (not shown) can provide auxiliary/standby power as required. A rudder 309 and elevator 310 combination is provided to assist in guiding the vessel under control of a guidance system.

The drone is arranged to operate in a semi-submerged position relative to the waterline 311 as depicted in the drawings, with the wing sail 308 erected above the waterline to collector ambient solar energy. The drone 300 further includes a guidance system 315 having a GPS receiver remote with automatic sequencing, and tracking storage. Sensors for << ?? >> are integrated into the wing sail assembly, whilst a sonar 320 and other oceanographic sensors 321 are disposed on the hull 301 or keel 312.

The drone vessel will have an almost indefinite operating range (at least in favourable weather) when loitering at 3 knots; a range of 280 to 1,600 km (200 - 1,000 miles) depending on fuel cell state at 6-8 knots; and a range of 100 to 1,000 meters (# - # yards) at 20 knots.

Turning to FIGs 7 and 8, there is depicted a drone vessel 400 of a third embodiment of the invention which is suited to delivery of a higher capacity payload. The vessel has a hull assembly, which includes a central hull 401 and two floats 402 with respective outriggers 403, constructed of a composite material having an overall length of # meters (35 feet), a beam of # meters (29 feet) and a weight of 1500 kg for a payload capacity of 500 kg. A pair of wing sails 404 having photovoltaic cells 405 disposed thereon is provided on the central hull 401 to capture both wind and solar energy. Each wing sail 404 is attached to the hull such that it may be declined along or laterally of the hull assembly when not

required for wind propulsion purposes. The declined position of the wing sails reduces the silhouette of the vessel whilst optionally allowing collection of solar energy. Further photovoltaic cells 406 are mounted between the outriggers 403 to enhance the surface area available for collection.

It is estimated that the payload, which includes << ?? >> would require power of about 1 to 2 kW. A wind-solar hybrid propulsion system of the kind described in relation to FIG. 1 is provided. The propulsion system is estimated to provide 10 to 15 knots with the wing sails erected before 15 to 25 knot winds, and the solar collection is estimated to deliver an average vessel speed of 4 knots for 24 hours, using an electric motor driven propeller 406. The system thus provides an average speed of about 6 knots and a potential maximum speed of 25 knots. The vessel further includes a guidance system, including a GPS receiver with automatic sequencing, and tracking storage.

An unmanned drone vessel 500 of a fourth embodiment of the invention is depicted in FIGs 9 to 11. The vessel includes an enclosed hull 501 that is about 4 metres (# feet) long and 1 metre (# feet) wide at widest near the stern 502 on surface. The vessel includes a single wing sail 503 attached to the hull 501 such that it may be erected or declined, either along 503a the hull (as shown in phantom in FIG. 9) or laterally 503b of the hull (as shown in phantom in FIG. 11). The surface of the wing sail is covered on at least one side with photovoltaic cells 504 for collecting solar energy. A lateral declination of the wing sail 503 provides the vessel with a reduced silhouette, whilst allowing solar energy collection from both cells 504 disposed on the wing sail and further photovoltaic cells 505 provided on upper surface or deck portions of the hull, both fore and aft of the wing sail.

An internal payload bay 506 is provided in the forward portion of the hull 501, whilst an aft compartment contains a deployable life raft of conventional construction. The life raft is deployed by pressing a panel 507, identified on the side of the hull with a red cross, is provided for search and rescue use in circumstances of a person overboard or aircraft ditching. A hand-rail may be provided on the deck to assist persons in the water. An alternative embodiment for remote fire fighting use, the vessel may include fire-fighting equipment.

Optical and infrared sensors 508 provided in a forward cowl portion sitting proud of the deck assist in locating heat sources when operated in search mode.

When these and other environmental sensors are linked to a navigation sub-system in this way, the unmanned drone operates as an intelligent life preserver which can be deployed from a larger ship to find and stay with the victim in the man overboard situation.

The vessel 500 includes a control system providing robot intelligence for executing a pre-programmed mission. This allows the drone to avoid ships, conduct a 'man overboard' rescue mission and optimise energies, e.g. sail in a circle to get to a point by following currents, use a burst mode communications sub-system to report unusual activity and the like. Various aerial arrays 509 for communications purposes may be integrated into the wing sail or mounted on the stern, as shown in FIG. 9.

The vessel includes a hybrid propulsion system of the general type discussed in relation to FIG. 1. The system includes an electric motor 510 supplied by a battery bank 511 and mechanically driving a propeller 512. The electric motor, which is rated at 50W, is considered to require 40 W to drive the propeller to achieve a typical cruising speed of 3 knots. It will be appreciated that the cruising speed is limited to renewable energy plus any available stored energy.

The embodiment further includes a power supply requiring 40W continuously for electronics supporting control, surveillance and communications requirements. Thus the estimated total power requirement is 80 W continuous. In combination the solar cells 504 on the wing sail and the solar cells 505 on the deck provide a collector area of approx. 4 m^2 (# sq ft) solar, at a typical efficiency of 15% can deliver 600W. Higher efficiency solar cells, such as employed by NASA, may achieve of the order of 30% efficiency.

When operating on solar power alone, 4 hours of sun will typically produce 2.4 kW. This with an estimated 40% losses with conventional batteries, the drone will have 1.2 kWhrs of energy which can provide 15 hours and 45 nautical miles of travel on solar energy alone. With high efficiency solar cells, this should double and improvements to batteries could double that again. Accordingly, 4.8kWh with 10% losses will give 54 hours of cruising operations over approximately 160 nautical miles. This is supplemented by wind, wave and other energies, such as a reversible fuel cell, which are optimised in the system.

In favourable weather conditions, where both sunshine and wind is available, the drone vessel has an almost an indefinite energy supply at loiter

speeds. Cruising speed however is limited to renewable energy plus stored energy.

YOUR DRAWING (NOW FIG. 9) INLCUDES A BLOCK LABELLED "ISSNMP tech". IS THIS A REFERENCE TO THE Simple Network Management Protocol ? OR SOMETHING ELSE - PLEASE ADVISE.

IT IS STRONGLY SUGGESTED THAT A BLOCK DIAGRAM OF THE PROPOSED GUIDANCE, CONTROL AND COMMUNICATIONS SYSTEMS IS INCLUDED IN THE SPECIFICATION, PARTICULARLY IN VIEW OF FUTURE USA PATENT DISCLOSURE REQUIREMENTS - PLEASE ADVISE, TO BE INCLUDED AS FIG. 12

In considering operation of a hybrid propulsion system which is characterised by the use of renewable energy, i.e. non-terrestrial, non-fossil fuel powered, the system may be operated in a number different modes, including:

1. Wind energy only (direct sailing);
2. Wind energy with electrical re-generation ('regenerative sailing'), i.e. excess wind spinning a propeller;
3. Wave energy (when loitering at a predetermined location); and
4. Solar energy, alone or in combination with 1-3 above.

Other proposed renewable energy sources include the use of temperature differential, ocean current (wherein a network of drones might flow, i.e. multiple drones could form a circular procession following current and wind patterns and yet total group covers the same area by like a cell network), salinity (using sea water as part of a battery or fuel cell), magnetism, ions, laser recharging from mirrors on satellites, and other renewable energy sources allowing the vessel to stay at sea substantially indefinitely without a terrestrial source of power. The drone vessel network may be arranged in a variety of patterns of coverage, including scouts, swarms, hives, schools, lines, grids, networks, perimeters, Chi patterns, etc.

INDUSTRIAL APPLICATION

An unmanned drone constructed in accordance with a preferred embodiment of the invention, utilizing off-the-shelf sensors and instruments, could do the work now done by (relatively few) manned ships but at a greatly reduced cost. The drone would complement advances that have already been made in satellite and airborne imaging and sensing. The drone also provides a mobile and self-powered platform that would provide the dwell time required for warfare, exploration, and research and monitoring in-situ. The drones will be able to go to sea for extended periods of up to years without refuelling or maintenance, using renewable energy such as solar and wind.

The drone vessel of the invention may be configured for a number of functions, including:

- Long term patrol;
- Geo-stationary buoy function;
- Interception of targets;
- Clandestine/stealth operations;
- Intelligence gathering;
- Sensing of water and air, for pollution, smugglers illegal operations;
- Interception of electromagnetic transmissions;
- Detection;
- Surveillance;
- Protection of ships when docked in a habour from attack;
- Sea rescue and retrieval;
- Underwater retrieval; and
- Underwater surveillance.

It is to be understood that the above embodiments have been provided only by way of exemplification of this invention, and that further modifications and improvements thereto, as would be apparent to persons skilled in the relevant art, are deemed to fall within the broad scope and ambit of the present invention defined in the claims which follow.

CLAIMS

1. An unmanned submersible drone vessel for operating either at or below the surface of a body of water, said vessel including:

- an enclosed hull having a payload bay;
- a hybrid propulsion system having energy collection means and energy storage means adapted for utilising at least solar energy and wind energy;
- a plurality of sensors for detecting predetermined environmental parameters; and
- a communications system for transmitting data from said sensors about selected environmental parameters to, and for receiving command signals from, one or more remote stations and/or cooperating drone vessels.

2. The unmanned submersible drone of claim 1 wherein the outer configuration of the hull has an outer configuration having the general appearance of an aquatic animal.

3. The unmanned submersible drone of claim 1 wherein the enclosed hull is adapted to facilitate selective operation at or below the water surface.

4. The unmanned submersible drone of claim 3 wherein the vessel includes ballast tanks for selective submerging and surfacing of the drone vessel.

5. The unmanned submersible drone of claim 1 wherein the hybrid propulsion system includes a wing sail having an aerofoil configuration for propelling the vessel using wind energy and having solar energy collectors disposed on the surface of the wing sail.

6. The unmanned submersible drone of claim 5 wherein the wing sail may be lowered to a declined position along the hull of the drone to reduce drag whilst continuing to collect solar energy.

7. The unmanned submersible drone of claim 1 wherein the energy storage means includes electrical storage cells, such as batteries or capacitors, coupled to solar energy collectors.

8. The unmanned submersible drone of claim 7 wherein the hybrid propulsion system includes an electrical machine mechanically coupled to a fluid drive element, wherein the electrical machine may be supplied from the storage cells to drive the fluid drive element in a motor mode or, in the alternative, the electrical machine may be driven by the drive element through wave action, water currents or during regenerative sailing to charge the storage cells in a generator mode.

9. The unmanned submersible drone of either claim 7 or claim 8 wherein the capacitors or other rapid energy discharge devices, such as fluid accumulators, provide the drone vessel with a short sprint capability.

10. The unmanned submersible drone of claim 1 wherein the payload bay is internally powered in order to carry electronic equipment supporting the environmental sensors for oceanographic or military use, live-saving or fire-fighting equipment for search and rescue, and/or weapons relating to desired drone vessel operations.

11. The unmanned submersible drone of claim 1 wherein the environmental sensors may include sensors selected from the group including:

anemometers,
wind vanes,
radars,
optical band sensors,
infrared band sensors,
chemical/biological sensors,
ocean current sensors,
acoustic sensors, and
bathymetric sensors.

12. The unmanned submersible drone of claim 1 wherein the communications system may include a GPS receiver, a LFB/SWB/marine band receiver, and a satellite receiver, together with suitable antenna arrays.

13. The unmanned submersible drone of claim 1 wherein the drone is able to dive under the surface for prolonged periods using stored energy to avoid ships, storms or for stealth operations.

14. The unmanned submersible drone of claim 1 wherein the hybrid propulsion system further includes a fuel cell for emergency use, such as emptying ballast tanks, to surface after a prolonged period of submerged operation.

15. The unmanned submersible drone of claim 1 wherein the hybrid energy propulsion system further utilises, in addition to wind energy and solar energy only renewable energy sources, including:

wave energy;

temperature differential; and

sea water activated batteries or fuel cells.

ABSTRACT

An unmanned submersible drone vessel (500) for operating either at or below the surface of a body of water, said vessel including an enclosed hull (501) having a payload bay (506); a hybrid propulsion system (100) having energy collection means (504, 505) and energy storage means (511), suitably in the form of a wing sail (503) covered with photovoltaic cells, adapted for utilising at least solar energy and wind energy; a plurality of sensors (508, #) for detecting predetermined environmental parameters; and a communications system (509, #) for transmitting data from said sensors about selected environmental parameters to, and for receiving command signals from, one or more remote stations and/or cooperating drone vessels.
(FIGs 9 and 11)

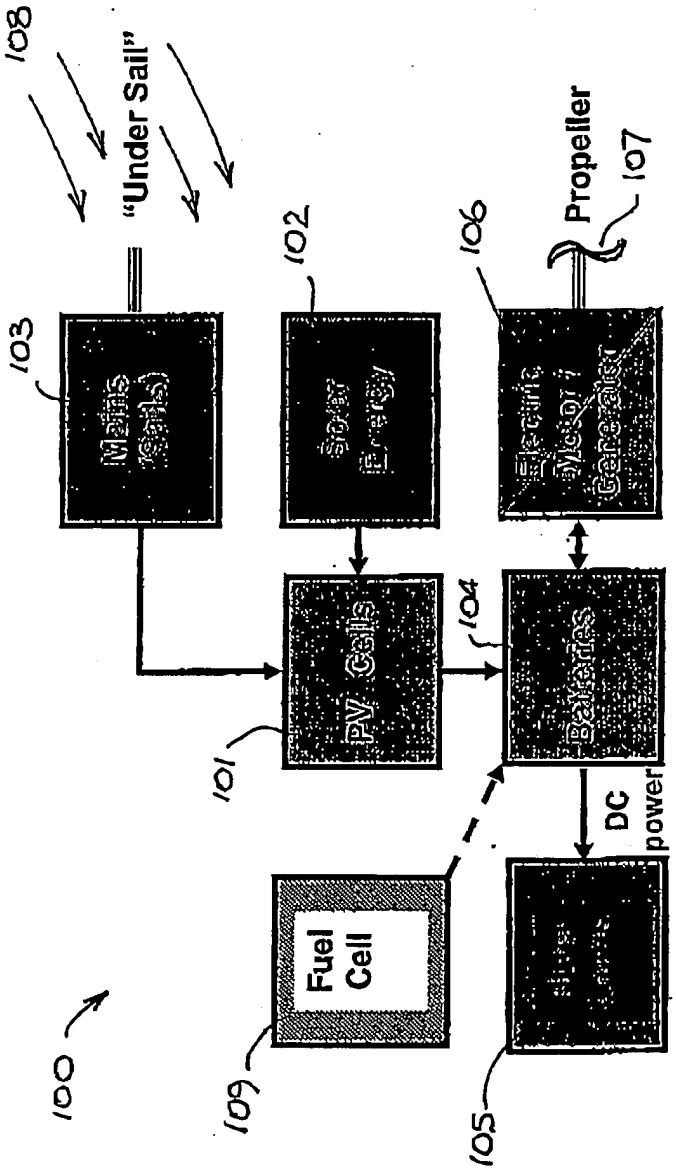
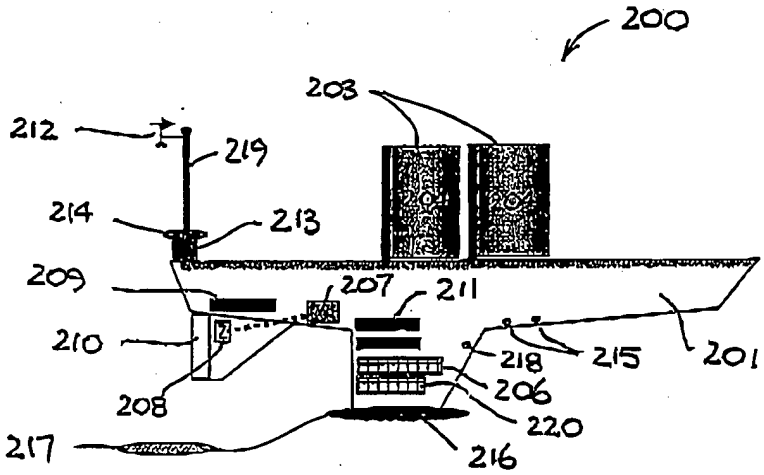

108
"Under Sail"
103
Mains (sails)
102
Solar Energy
106
Propeller
107
Electric Motor / Generator
101
PV Cells
104
Batteries
DC power
Fuel Cell
109
105
100

FIG. 1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213
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201
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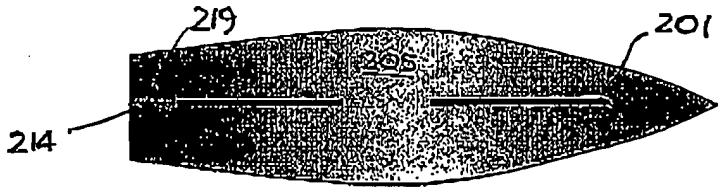
220
217
216

FIG. 2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201
205
214

FIG. 3

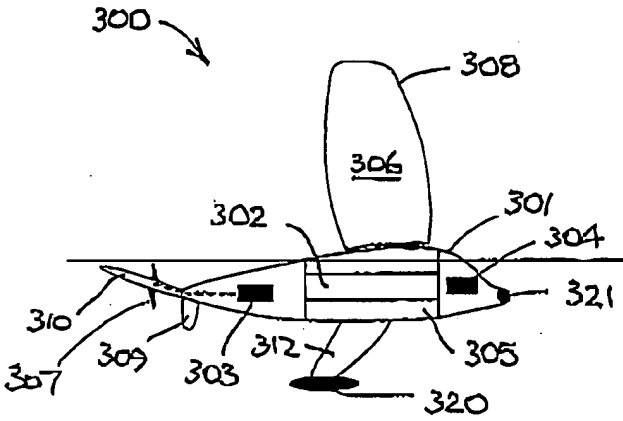


FIG. 4

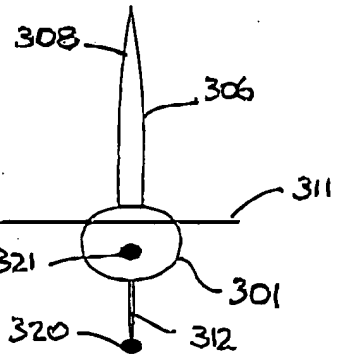


FIG. 5

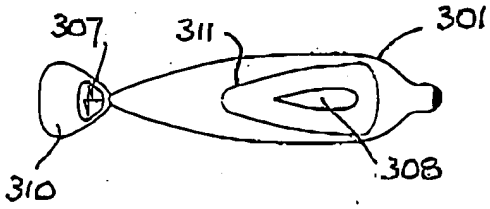


FIG. 6

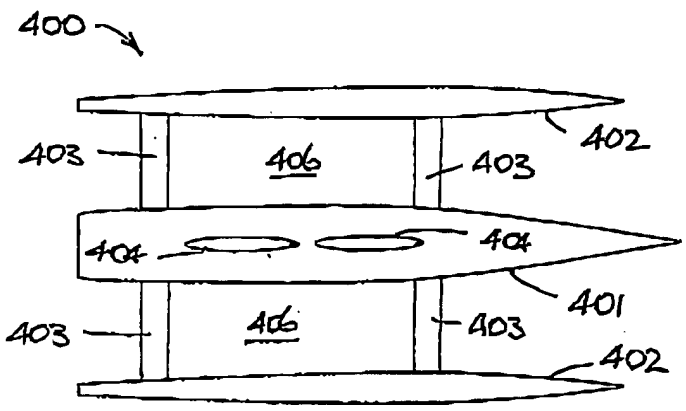
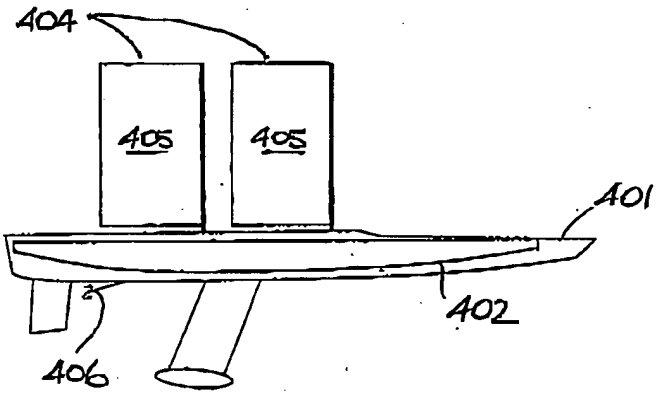

400
402
403
406
403
404
404
401
403
406
403
402

FIG. 7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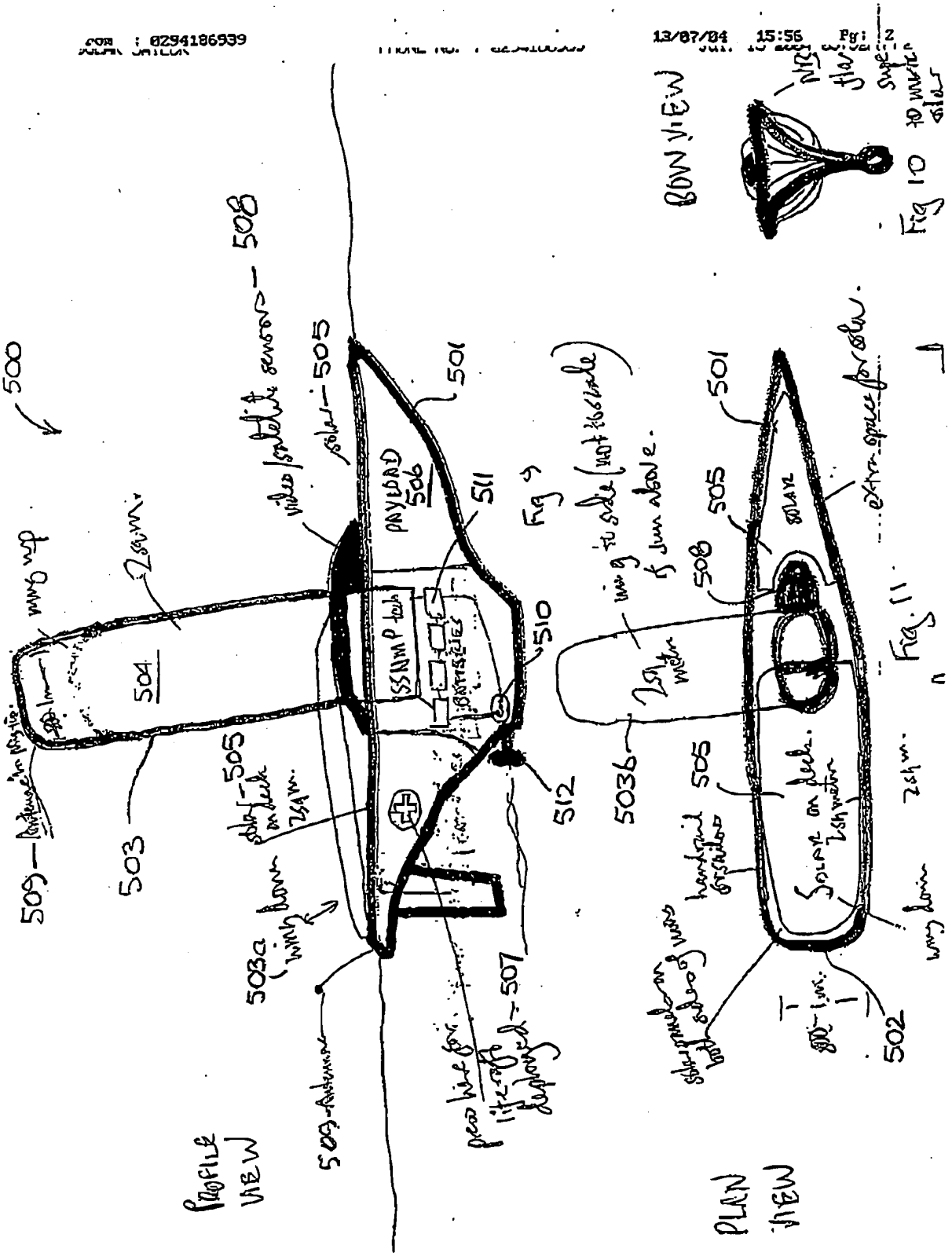
401
402
406

FIG. 8


PROFILE VIEW
PLAN VIEW
500
501
502
503
504
505
506
507
508
509
510
511
512
5036
PAYLOAD
SOLAR
Fig 10
Fig 11

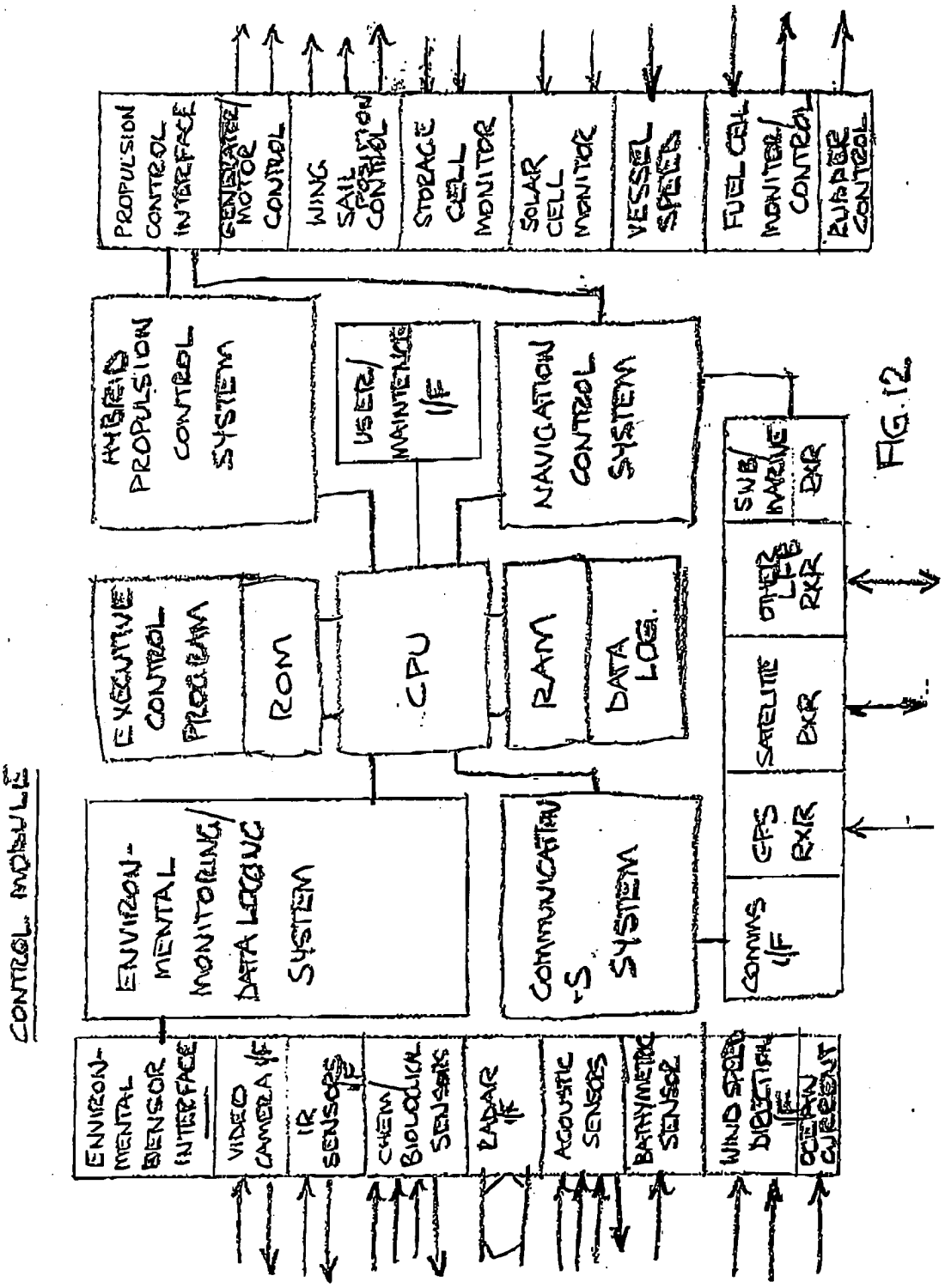

CONTROL MODULE
PROPULSION CONTROL INTERFACE
GENERATOR/ MOTOR CONTROL
WING SAIL CONTROL
STORAGE CELL MONITOR
SOLAR CELL MONITOR
VESSEL SPEED
FUEL CELL MONITOR/ CONTROL
RUDDER CONTROL
HYBRID PROPULSION CONTROL SYSTEM
USER/ MAINTENANCE I/F
NAVIGATION CONTROL SYSTEM
SWB/ MARINE RXR
OTHER LOS RXR
SATELLITE RXR
GPS RXR
COMMS I/F
EXECUTIVE CONTROL PROGRAM
ROM
CPU
RAM
DATA LOG.
ENVIRON-MENTAL MONITORING/ DATA LOGGING SYSTEM
COMMUNICATIONS SYSTEM
ENVIRON-MENTAL SENSOR INTERFACE
VIDEO CAMERA I/F
IR SENSORS
CHEM/ BIOLOGICAL SENSORS
RADAR
ACOUSTIC SENSORS
BATHYMETRIC SENSOR
WIND SPEED DIRECTION I/F
OCEAN CURRENT

FIG. 12

EXHIBIT B to PETITION FOR RETROACTIVE FOREIGN FILING LICENSE

Filing Receipt for US Provisional Patent Application Serial No. 60/599,784

BLANK ROME LLP

UNITED STATES PATENT AND TRADEMARK OFFICE

SEP 17 2004

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

RECEIVED
COUNSELORS AT LAW

APPL NO.	FILING OR 371 (c) DATE	ART UNIT	FIL FEE REC'D	ATTY.DOCKET NO	DRAWINGS	TOT CLMS	IND CLMS
60/599,784	07/22/2004		80	597000.01111 (SS)	6		

CONFIRMATION NO. 2688

27557
BLANK ROME LLP
600 NEW HAMPSHIRE AVENUE, N.W.
WASHINGTON, DC 20037

FILING RECEIPT

OC000000013791818

Date Mailed: 09/16/2004

Receipt is acknowledged of this provisional Patent Application. It will not be examined for patentability and will become abandoned not later than twelve months after its filing date. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Filing Receipt Corrections, facsimile number 703-746-9195. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).**

Applicant(s)

Robert A. Dane, Sydney, AUSTRALIA;

121432.0101
foreign filing 9/22/05

Power of Attorney:
Michael Greenbaum--28419

If Required, Foreign Filing License Granted: 09/13/2004

The number of your priority application, to be used for filing abroad under the Paris Convention is,
US60/599,784

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

Unmanned drone vessels

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Office of Export Administration, Department of Commerce (15 CFR 370.10 (j)); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Robert A. Dane et al.	
Application No.: 10/565,449	Confirmation No. 9828
Filed: August 1, 2006	Group Art Unit: 3617
Title: UNMANNED OCEAN VEHICLE	Examiner: Vasudeva, Ajay
Attorney Docket No.: SOLAR 1	

Mail Stop Petitions
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Declaration of Mark A. Smith in Support of Petition for Retroactive Foreign Filing License

I, Mark A. Smith, declare and say:

1) I am the attorney with responsibility for global patent strategy and execution for the invention claimed in the above-captioned patent application. I have personal knowledge of the information contained in this Declaration. I am submitting this Declaration in support of the Petition for Retroactive Foreign Filing License in the above-captioned patent application.

2) To the best of my knowledge, the subject matter in the above-captioned patent application was not under a secrecy order at the time it was filed abroad, and it is not currently under a secrecy order.

3) The subject matter in the above-captioned patent application was filed abroad through error and without deceptive intent without the required license under § 5.11 first having been obtained.

a) A provisional patent application was filed in Australia (Application No. 2004902116) on April 21, 2004 without the required foreign filing license.

i) This Australian provisional patent application was filed in the name of applicant Solar Sailor Pty Ltd, without naming any inventors, as is acceptable practice under Australian patent law. See attached Declaration Exhibit A which is a printout from the Australia Patent Office website showing the bibliographic data for Australia Provisional Patent Application No. 2004902116. As seen in Declaration Exhibit A, there are no inventors named in this provisional patent application.

ii) Because no inventors were named in the Australian provisional patent application, no determination of the potential inventors was made and therefore the need for a foreign filing license was not considered.

iii) The failure to obtain a foreign filing license prior to filing Australian Provisional Patent Application No. 2004902116 was an unintentional error that was made without deceptive intent which simply resulted from neglecting to identify the inventors prior to filing the Australian provisional patent application.

b) A PCT application (International Application No. PCT/AU2004/001014) was filed on July 30, 2004 without the required foreign filing license.

i) I am not a US patent attorney and therefore not an expert on US patent law and the requirement for a foreign filing license. While a US inventor was named in the PCT application, it did not occur to me at the time of the PCT filing that a foreign filing license might be required (although this did occur to me later, as discussed below in 4a).

ii) Even if it had occurred to me at the time of the PCT filing that a foreign filing license might be required, I likely would have dismissed the concern because I knew that a US provisional application had already been filed.

iii) The failure to obtain a foreign filing license prior to filing International Application No. PCT/AU2004/001014 was an unintentional error that was made without deceptive intent which simply resulted from failing to appreciate the need for a foreign filing license in this situation.

4) The retroactive foreign filing license is being diligently sought after discovery of the proscribed foreign filing.

a) While I am not a US patent attorney and therefore not an expert on US patent law and the requirement for a foreign filing license, I identified the potential need for a foreign filing license in November, 2004 and raised this issue with the applicant/assignee named in the Australian provisional patent application. At that time, I recommended to the applicant/assignee that a US patent attorney be consulted to determine an appropriate course of action, if any action was required under the circumstances. I received no further instructions including on this point, since the applicant/assignee was instructing its former US counsel directly at that time, other than to close our file.

b) While preparing to instruct the current US counsel to pay the issue fee in the above-captioned patent application, I reviewed my files and recalled the US provisional patent application number 60/599,748 had been filed on July 22, 2004. Upon reviewing my file I noted my November 2004 recommendation to consult a US patent attorney regarding the potential need for a foreign filing license. I do not believe that a retroactive foreign filing license has previously been sought or obtained. This discovery occurred on or about April 26, 2010.

c) On April 26, 2010, I contacted the current US counsel to arrange a teleconference to discuss how to address this issue.

d) On April 28, 2010, I spoke to the current US counsel via telephone. We discussed the need to file a petition to obtain a retroactive foreign filing license.

e) Between April 28, 2010 and May 3, 2010, I secured from the former US counsel the information necessary to support a petition to obtain a retroactive foreign filing license.

f) On May 3, 2010, I instructed the current US counsel to prepare and file a petition to obtain a retroactive foreign filing license.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: May 7, 2010

Mark A. Smith

EXHIBIT A to DECLARATION OF MARK SMITH IN SUPPORT OF PETITION FOR RETROACTIVE FOREIGN FILING LICENSE

Bibliographic Data for Australia Provisional Patent Application No. 2004902116

MySearches (0)

Application Details

2004902116 : Advanced Technology Watercraft

BIBLIOGRAPHIC DATA

Application details

Australian application number	2004902116	**Patent application type**	Provisional
Application status	LAPSED		
Currently under opposition	No	**Proceeding type(s)**	
Invention title	Advanced Technology Watercraft		
Inventor(s)	Not Given		
Agent name	PIZZEYS	**Address for legal service**	Level 14, ANZ Centre 324 Queen Street Brisbane QLD 4000 Australia
Filing date	2004-04-21		
Associated completes			

Applicant details

Applicant	Solar Sailor Pty Limited	**Applicant address**	Suite 206 "The Bentleigh" 1 Katherine Street Chatswood NSW 2067 Australia
Old name(s)			

FEE/PUBLICATION HISTORY

Publication history

Vol/Iss	Publication date	Publication action	Reason	Document kind
18/18	2004-06-13	Provisional Applications Filed		

This data is current as of 2010-04-28 18:00 AEST.

United States Patent and Trademark Office
- Sales Receipt -

05/10/2010 NNICHOLS 00000002 502127 10565449

01 FC:1463 200.00 DA